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PLAIN, PRAIRIE, AND FOREST.

BY PROF. J. D. WHITNEY.

PART I.

IN spite of all that has been written in regard to the distribution of forests on the North American continent, and the origin of those treeless plains to which the name of prairie is given, the subject is one possessing a great deal of interest, since there is far from being any unanimity of opinion about the various points which are involved in it. The publication of Professor Brewer's map, showing in five degrees of density the distribution of woodland within the territory of the United States, and which is one of the series of charts included in General Walker's Statistical Atlas, seems to offer a convenient occasion and excuse for reverting to the subject of the physical conditions influencing the growth of forests. This has long been a favorite theme with the writer of the present article, and during the twenty years which have elapsed since he has published anything in regard to it, he has had many opportunities of making observations on the distribution of plain, prairie, and forest within the borders of the United States, having crossed the continent several times by various routes lying between Wisconsin and Missouri. In these journeyings he has availed himself of the excellent sections afforded by the various railroad lines crossing the States of Indiana, Illinois, Iowa, and Missouri, accumulating observations which, taken in connection with those previously made during several years of detailed geological work in the heart of the prairie region, enable him to speak from personal knowledge of a wide extent of country, embracing, indeed, a large portion of that area of mingled forests and prairies to a discussion of which this article is to be chiefly devoted.

The use of the word "prairie," which corresponds very nearly with our "meadow," meaning a grassy, treeless, nearly level

area, dates back to the days of the very earliest explorers of the Mississippi Valley. Father Hennepin describes the prairies along the Illinois River exactly as any other observer would now do. He says, "Elle [the river] est bordée de côteaux [bluffs] dont la pente est couverte de bois et de grands arbres. Quand on est sur ces côteaux, on découvre de belles prairies à perte de vûë, garnies d'espace en espace de petits bois, qui semblent avoir été plantez exprès." The distinction between prairie and plain is one which has come gradually into existence as the routes of the emigrant and the explorer have extended themselves farther and farther to the west. Every one knows that the "Prairie States" are those lying contiguous to the Mississippi, on both sides, from Minnesota and Wisconsin down to Arkansas, and that Illinois and Iowa are typical prairie regions. All understand what the phrases "crossing the plains," and "out on the plains," mean; and no Western man would confound the terms prairie and plain. When we reach the Rocky Mountains, and find grassy areas distributed among the ranges, we learn that they are there called "parks" and "holes." This is true, at least, for the central portion of the country, in Colorado and Utah; farther north, in Dakota and Montana, the term prairie is also in use.

For our present purpose it is unnecessary to trace the gradual disappearance of the forests as we proceed west from the well-wooded region of the Appalachian ranges and the Great Lakes. That the distribution of woodland within our territory is in general more influenced by the amount of moisture or the quantity of rain which falls than by any other cause is admitted as a fact beyond dispute. A comparison of the Smithsonian rain-charts with Professor Brewer's map shows this at once. An interesting article might be written on the distribution of the forests over the vast region west of the Rocky Mountains, but with that we have not now to do. It is to the prairie region proper that we propose to devote the present article.

The prairies lie between the forest-covered portion of the country and the plains; hence the idea which seems so firmly fixed in the minds of many, that prairie and plain are the same thing; or, rather, that one is simply passage into the other, the prairie being, so to speak, the incipient plain. It will be necessary, therefore, at first, to show that there is an essential difference between the two kinds of surface, and that their juxtaposition is quite accidental, or certainly depending on other causes than those to which it is commonly attributed.

The prairie is a heavily-grassed area, destitute of forest growth, but existing in the midst of a wooded region, where the climatological conditions are favorable to the growth of timber, but where some other cause than the want of sufficient moisture has operated to prevent this growth. To illustrate how character and distribution of forest and prairie are independent of climatological conditions, let us take the State of Wisconsin, which has an area of about fifty-four thousand square miles, the ninetieth meridian passing nearly through its centre. The northern portion of the State belongs among the most densely wooded regions in the country. This heavily-timbered belt extends from Lake Superior south to the forty-fifth parallel. The sugar-maple is the predominating tree. South of this is a region of pines, not as thickly crowded together as are the trees in the region to the north, but constituting fine forests; still farther south, and occupying the whole area south of the Wisconsin River, is a region of mingled forest and prairie, the trees being chiefly oaks. The cause of this peculiar distribution of the timber in Wisconsin will be noticed farther on; at present it is only desired that the attention of the reader should be called to the entire want of harmony of this arrangement of forest and prairie with the climatological conditions. The Smithsonian charts show a greater amount of precipitation over the prairie area than anywhere else in the State. By no amount of ingenuity can the peculiarities of the isothermal or isohyetal lines be made to play in with the marked differences of the vegetation.

Equally striking are the changes which are met with as one passes from the State of Indiana into the adjacent one of Illinois. The former of these is forest-covered, woodlands extending over probably as much as seven eighths of its area; Illinois, on the other hand, is *par excellence* the prairie State, not more than a quarter or at the most a third of its surface being covered with timber. Here, again, there is nothing to coincide with the distribution either of rain or of temperature; the division seems a purely arbitrary one until looked at in the light of geology. These are only two instances, out of many which might be cited, going to show the absence in certain regions of any essential connection between climate and distribution of forests, and these are sufficient at any rate to indicate the desirability of inquiring what other causes may exist, determining, at least to a considerable extent, the curious intermixture of grassed and timbered areas which we find in the prairie region proper.

The writer has no theory to put forward on the subject; he has simply gone on for years observing the facts, and it is a very brief *résumé* of these facts which it is here proposed to give. But he will first endeavor to dispose of some of the theories of others, declaring that he believes himself to have had better opportunities for observing in the prairie region than any of the writers who of late years have taken up this subject.

There seem to be two prominent theories before the public for their choice in accounting for the existence of the prairies. One of these may be very shortly disposed of, since it is so at variance with all the facts that, as Mr. Foster observes,¹ it is "worthy only of a passing notice." It is to the effect that the prairies exist because the trees have been burned off by the Indians! To use the words of Mr. St. John, formerly State Geologist of Iowa, and one of the most zealous upholders of this theory, "The real cause of the present existence of the prairies is the prevalence of the annual fires. If these had been prevented fifty years ago, Iowa would now be a timbered instead of a prairie State." There seem to be some Western men who are not content unless they can make their country out to be not only the garden but the arboretum of the world. The trees are wanting at present over extensive areas; but they must once have existed, otherwise the Mississippi Valley would be or have been deficient in one of those attributes by which an ideally perfect country is characterized. As the trees do not now exist, they must have been destroyed, and, no other agent being at hand so destructive as fire, that is had recourse to. The prairie grass frequently gets on fire; these fires have burned up the trees! Why the same conditions do not hold good on the present forest-covered States has never been explained. Why the fires have spread themselves only on comparatively level ground, and spared the mounds and the bluff sides of the rivers, is also a mystery; equally so why they have avoided certain tracts quite surrounded by prairie, like the "groves" of Wisconsin; and, furthermore, why they have paid such respect to the differences of soils and other geological conditions. We have seen large areas of forest burned over, both in New England and on Lake Superior, as well as in the Rocky Mountains, but have no recollection of any of these areas having become prairies in consequence. Once a forest, always a forest, so far as our experience

¹ The Mississippi Valley, page 76. Dr. Newberry says the idea is "simply puerile." (Geology of Ohio. i. 30.)

goes, unless the hand of man comes in to interfere with nature. Mr. N. H. Winchell, although an advocate of the prairie fire theory, seems much impressed with one of the difficulties which it presents, namely, the irregularity with which prairie and forest are intermingled. Speaking of the "Big Woods" of Minnesota, a belt of timber some forty-five miles wide, running from the centre of the State to the northern boundary of Iowa, he says, "The existence of this great spur of timber, shooting so far south from the northern forests, and its successful resistance against the fires that formerly must have raged annually on both sides, is a phenomenon in the natural history of the State that challenges the scrutiny of all observers." We wonder that it had not led him to scrutinize his own theoretical ideas. Of the real cause of the existence of these "Big Woods" we will speak farther on.

By some writers on the theory of the prairies it is held that, as trees can be artificially made to grow upon them, therefore they must originally have been covered by a forest vegetation. This is as if one should argue that because the western part of the State of New York is covered with flourishing wheat fields, and because grain can be raised there with ease, therefore that region must have been always a treeless one!

Let us turn now to the other and by far the most prominent theory advanced to account for the existence of the prairies. It is this: that these treeless plains are in some way a product of the climatological conditions of the country. The only causes connected with climate which we can conceive of as likely to influence the growth of forests are temperature, force of the winds, and moisture; if the latter be the effective agent in determining the position of the wooded regions, then it may be through either excess, deficiency, or irregular distribution of the moisture that the result is attained. In regard to the first of these causes, namely, temperature, we are not aware that this has ever been suggested as having anything to do with the phenomenon in question. There seems to be nothing in the distribution of the isothermal lines in the Mississippi Valley which could be in any way connected with the presence or absence of forests, and certainly nothing connected with the details of the distribution of woodland and prairie could be at all explained by reference to temperature. In regard to the winds, it will be admitted that these do sweep pretty severely over the prairie region, for the reason that it is mostly flat, and therefore unshel-

tered. That the winds on the Pacific coast are, in places, inimical to the growth of forests seems very clear, but this does not seem to be the case in the Mississippi Valley, for we often find the most abundant growth of trees on the very spots which are most exposed to the force of the blast. It is on the rising ground, the knobs, knolls, and mounds which are scattered over the surface of the prairie, that those isolated clumps of timber, called groves, are most likely to be found. If the force of the wind were essentially inimical to the growth of trees, we should find them thriving, if anywhere, in the sheltered nooks, and to the leeward of the northwesterners, that being the quarter from which the heaviest blasts come. This is not the case, nor is there anything, so far as we have observed, which would lead to the conclusion that the force or direction of the wind has any sensible effect on the growth or distribution of the timber in the prairie region.

The only climatological cause for the existence of the prairies which is worthy of serious consideration in this connection is the distribution of moisture, and by far the larger number of those who have written on this question have unhesitatingly asserted that in something connected with the rain-fall was to be found the really efficient agent by which the distribution of woodland and prairie has been effected. Exactly what this something is seems, however, not easily to be made out. It must, as it would appear, be one of four things: either the annual rain-fall is on the whole deficient, or it is not favorably distributed through the seasons, or the climate is subject to cycles of drought, or there must be an excess of moisture. In one or other of these categories the influence of the rain-fall must be found, or if not in one single condition of these here enumerated, then in some combination of them.

Let us first examine whether the average annual rain-fall is really deficient, so that the absence of trees over a considerable portion of the Mississippi Valley may be referred to this as a cause. And to settle this question we have no better method than that of comparison between the wooded and prairie regions, taking the Smithsonian rain-charts as a basis for our statements. These charts are, of course, for many districts only rough approximations; for it is, over a large part of the country, only within a few years that statistics have begun to be collected. The data seem, however, to be sufficient for our purpose. If now we examine these charts, we find that for the typical prairie region,

namely, Southern Wisconsin, Illinois, Eastern Iowa, Missouri, and Arkansas, there is no deficiency of rain-fall indicated. Beginning in the densely-wooded region of Northeastern Maine, and following along through the forest-covered districts of Northern New Hampshire and Vermont, New York, the southern part of Upper Canada, the southern part of Michigan, Ohio, Indiana, and so on as far as the Des Moines River, we find spread upon the chart a uniform tint of color, designating an annual rain-fall, over the whole area indicated, of from thirty-two to forty-four inches. This same shade of color extends down and covers almost the whole of the densely-wooded Appalachian ranges in Pennsylvania, Virginia, and North and South Carolina. Looking at the curves which imperfectly divide the region in question, giving a greater amount of detail, we see that not only is the annual precipitation in general quite as great in the prairie region as in most of the ordinarily well-wooded parts of the country, but that when local causes have within certain areas given rise to an excess or deficiency, as compared with the general range of from thirty-two to forty-four inches, there is no corresponding difference in the relative abundance or scarcity of the forests. Thus the upper heavily-timbered part of Michigan shows a decided deficiency of rain-fall, while the only region in that State in which prairies occur over any considerable amount of surface, namely, the southwestern corner, is precisely that where the amount of rain is exceptionally large. Wisconsin, again, shows the same kind of anomaly, for here the prairie region is seen to have the largest amount of precipitation of any portion of the State. Once more: in Iowa, there is a district which is almost entirely covered with forests, namely, the northeastern corner; here, by a curious coincidence, the Smithsonian charts indicate a decided deficiency of rain; while farther west, in a line extending northwest from Iowa City, there is a large area of considerable extent marked as receiving from forty-four to fifty-six inches, and over which, as repeated explorations have convinced us, there is no corresponding increase in the amount of timber. Still more striking facts of the same kind may be had in abundance in Southern Missouri and Northern Arkansas, a region of abundant prairies and of precipitation as great as that of the wettest part of the Atlantic coast. Further statements of this kind do not seem to be necessary to justify the conclusion that in the prairie region there is no deficiency in the annual amount of rain, and that some other cause for the absence

of forests over a considerable portion of the Mississippi Valley must be sought for.

Let us next inquire whether there is anything in the distribution of the rain-fall throughout the year or from season to season which may possibly have a peculiar influence on the vegetation. That this is the case, and that this is, in fact, the predominant cause determining the existence of the prairie, is the theory advocated by Mr. J. W. Foster, at some length, in his work entitled *The Mississippi Valley*. Mr. Foster thus states his views: "Wherever the moisture is equable and abundant we have the densely-clothed forest, wherever it is unequally distributed we have the grassy plain, and where it is mostly withheld we have the inhospitable desert." That the last of these three dicta is true may be at once admitted. No one will deny that some moisture is necessary to the growth of vegetation, whether it consist of trees, shrubs, or grasses. The other parts of this statement, as we contend, are entirely erroneous. And no better instance can be given of the fact that an equable and abundant distribution of moisture does not always clothe the country with dense forests than that of the vicinity of Chicago itself, where Mr. Foster's book was written. Here we have one of the finest prairie regions in the world, absolutely destitute of trees, and yet in the full enjoyment of an abundant precipitation, and in the immediate vicinity of an immense sheet of water. For Chicago itself, indeed, the statistics of rain-fall are very defective, but such as they are, they are entirely unfavorable to Mr. Foster's hypothesis. Points in the immediate vicinity of that city, where observations have been taken for a series of years, show an annual average rain-fall of from thirty-six to fifty inches, pretty uniformly distributed through the year, as will be seen farther on. An excellent instance, on the other hand, of a dense growth of trees combined with the most unequally distributed rain-fall which is possible is furnished by the western slope of the Sierra Nevada of California, whose magnificent forests are well known, as also is the fact that there is no precipitation there at all for six months of the year, nearly the whole of the rain-fall being limited to three months. And, lest it may be thought that melting snow keeps the ground moist during the summer, it may be added that the heaviest forest belt of the Sierra is quite below the line above which snow rests for any considerable time, and that the soil in that belt is usually perfectly dry at the surface, and even dusty, for six months of the year, and often much more.

From other parts of Mr. Foster's chapters on the origin of prairies, in his work already cited, it would appear, however, that he considers the deficiency of rain in the winter months to be the essential cause of the absence of forests. He remarks as follows:¹ "A region where the annual precipitation is slightly in excess of twenty inches, I infer from observation, is unfavorable to the growth of trees, even were this moisture equally distributed, but where three fourths of it is precipitated during the spring and summer, the grasses flourish and mature to the exclusion of arborescent forms." This seems also to be the theory advocated by Dr. Newberry, from whom we quote as follows:² "Those who know anything of the climate of the prairie belt know that it is characterized by a *deficiency of winter rain* and snow, and by occasional though rare seasons of excessive dryness. The want of winter rains to deeply saturate the ground gives to the superficial hibernating grasses, which may be said to live upon the almost copious summer rains, an advantage over trees equal to a victory."

Let us now examine this question in the light of the Smithsonian rain-tables and Mr. Schott's discussion of them. This very point is taken up, under the head of Annual Fluctuation in the Rain-Fall, annual fluctuation, as Mr. Schott explains it, meaning the "changes from month to month." He gives the typical curve for the "region embraced in the Hudson River Valley, Vermont, and Northern and Western New York," as derived from an aggregate of five hundred and sixty-four years of observation. He also gives from the records of one hundred and fourteen years the curve for "the Upper Mississippi from Fort Madison, Southern Iowa, to Fort Ripley, Central Minnesota, and including part of Wisconsin." One of these regions, as will be readily seen, is a region of forests, the other of prairies. It would be difficult to select two districts in this country of equal area more characteristically situated for showing the difference between the rain-fall of a wooded and of a prairie country. Yet we find Mr. Schott declaring that the two curves thus obtained, and representing typically the distribution of the rain-fall throughout the year, "do not materially differ." In each case there are two maxima, one about the beginning of the summer and the other at its end, and also a principal minimum about the beginning of February. The only difference between the two types

¹ Mississippi Valley, page 101.

² Geology of Ohio, i. 30.

is that in the one case one of the maxima falls in September and in the other in October, and that the range is a little larger in the more westerly region. We find, on examination of the tables, that from about forty to forty-five per cent. of the total precipitation of the prairie region comes in the autumn and winter months, and that these conditions do not materially differ from those prevailing in some of the most densely-wooded portions of the country. To illustrate these points we append a table showing the amount of precipitation at some of those places in the prairie region where observations have been longest kept up, with additional figures from some portions of the densely-timbered country.

	PRECIPITATION, IN INCHES.				Total, in Inches.
	Spring.	Summer.	Autumn.	Winter.	
Peoria, Ill.....	10.00	10.34	8.46	7.03	35.83
Ottawa, Ill.....	9.89	11.25	8.68	7.37	37.19
Manchester, Ill.....	11.49	8.71	8.76	8.83	37.79
Athens, Ill.....	11.55	12.04	8.55	7.48	39.62
Pekin, Ill.....	10.44	12.50	9.45	8.86	41.25
Winnebago, Ill.....	9.72	12.31	9.66	6.14	37.83
Platteville, Wis.....	9.88	13.63	9.32	6.48	39.31
Dubuque, Iowa.....	7.10	10.53	9.38	5.23	32.24
Muscatine, Iowa.....	11.92	13.79	10.35	6.82	42.88
Iowa City, Iowa.....	11.27	13.04	13.11	5.70	43.12
Clinton, Iowa.....	11.40	13.94	10.40	7.98	43.72
Davenport, Iowa.....	10.70	13.71	8.56	6.49	39.46
St. Louis, Mo.....	12.42	13.04	9.07	7.65	42.18
Ontonagon, Mich.....	5.43	7.44	6.48	6.44	25.79
Marquette, Mich.....	6.49	9.02	8.11	6.39	30.01
Fort Brady, Mich.....	5.06	9.50	10.68	4.99	30.32
Detroit, Mich.....	8.51	9.29	7.41	4.82	30.03

The last four places are situated in thickly wooded regions, the others are on or near the prairies, and they include nearly all the localities in Illinois and Iowa where observations have been kept up for as much as ten years. Attention is called to the small annual amount of rain in the densely-timbered districts bordering on Lake Superior and Lake Huron, and also to the fact that there the statistics of its distribution through the seasons are much more unfavorable to the growth of forests, according to Mr. Foster's theory, than anywhere on the prairies.

In view of the above figures it may be unhesitatingly affirmed that there is no basis for the theory that an unequal distribution of rain throughout the year brings about a treeless condition of the surface. It is surprising that those who maintain that a deficiency of winter rain prevents the growth of trees should not

have recollected that over a large part of the forest region of the north and northeast there is, practically speaking, no precipitation at all in the winter, since the snow which then falls, to the exclusion of rain, accumulates on the frozen surface and does not begin to wet the ground until spring, when it, to all intents and purposes, by its melting adds so much to the spring precipitation, thus bringing the total effect exactly to a par with that which is claimed by Dr. Newberry as being fatal to the existence of forests.

When we come to examine into the conditions of the climate in Southern Missouri and Arkansas, which are also regions of extensive prairies, we find that there is still less reason for advocating a deficiency of moisture as the cause of the treeless condition of the surface than there is farther north in the States for which statistics have been given. The tables of the rain-fall are very deficient for the region west of the Mississippi and south of the Missouri. Arkansas, however, is put down on the Smithsonian charts as lying chiefly within the belt of forty-four to fifty-six inches of precipitation. There are only two stations where observations have been kept up for any length of time; these are Washington, in longitude $93^{\circ} 41'$ and latitude $33^{\circ} 44'$, and Fort Smith, on the extreme western border of the State. At these places a precipitation of 54.50 and 40.36 inches is indicated. Short series at Helena and in Union County give respectively 81.08 and 74.63 inches. Helena, with this enormous precipitation, is the nearest station to Prairie County, of which the surface is "mostly open prairie."¹ An examination of the Smithsonian charts will show that Southern Missouri is also a region of large precipitation. Here there is considerable prairie, some of it in the river bottoms. The region is a rough and broken one, and the conditions of soil and surface quite complicated with respect to distribution and character of timber. There is a considerable area covered with a scattered growth of oaks, locally known as "oak barrens." These, however, do not depend for their existence on any scarcity of moisture.

As there is no proof whatever that an occasional year of drought in the prairie region would be a sufficient cause for the absence of timber, and as there is, furthermore, no proof that this region is peculiarly liable to droughts, it is hardly necessary to take this matter into serious consideration. It would be easy to point out regions on the Pacific coast and elsewhere in which

¹ D. D. Owen, *First Arkansas Report*, page 242.

the distribution of the rain from year to year is very capricious, but where, none the less, the forests are well maintained. Mr. Schott's investigations give us no authority for saying that the prairie region is more liable to droughts than the region of forest immediately adjacent to it.¹

That an excess of moisture is in general prejudicial to tree-growth must of necessity be admitted. This fact seems to form the basis of the views of Mr. Lesquereux in regard to the origin of prairies. And to a considerable extent there is a harmony of opinion between us; indeed, the writer finds that this gentleman is the only one of those who have written on the prairies who has carefully observed the leading facts. Before, however, noticing his views, it will be well that the author of this article should state exactly to what results his own observations have led him, and what seems to him the all-important consideration influencing the character of the vegetation in the prairie region.

(To be concluded in the next number.)

CARNIVOROUS PLANTS.

BY PROF. W. J. BEAL.

THIS is a new term which has lately been applied to plants that catch insects by various contrivances.

In 1768, over one hundred years ago, Mr. Ellis discovered that the Venus fly-trap, of North Carolina, catches insects by a peculiar construction of the tips of its leaves, like a steel-trap. Numerous experiments have satisfied botanists that flies are not only caught, but digested by a fluid poured out by the plant, and the materials absorbed into the tissues of the plant. In 1780, ninety-five years ago, the sun-dew (*Drosera*) was found to catch insects by its sensitive hairs with a sticky gland at the end of each.

Drosera rotundifolia, a common little plant of our marshes, has a round leaf, about the size of a cent, sometimes containing

¹ See page 158 of Mr. Schott's paper. He says, "The observed succession of annual amounts of rain-fall on the Atlantic coast from Maine to Virginia, and in the interior of the State of New York, seems to be governed by the same circumstances or laws, as is evident by a comparison of the curves of Type I. [Maine to Virginia] and Type II. [State of New York], and indeed Type III., region of the Upper Mississippi (Iowa), bears some resemblance to these curves, but is not yet sufficiently developed to be pronounced identical in character. . . . The remarkable period of droughts about 1836, as well as the less conspicuous or relative one of 1855, are common to the two regions [Type I., State of New York, and Type IV., region of Upper Mississippi, Iowa]."